Study on Geomagnetic Variation of Telluric Origin Part III. On Geomagnetic Anomaly Observed at Some Hot Spring Areas

AUTHOR(S):

MIYAKOSHI, Junichiro

CITATION:

MIYAKOSHI, Junichiro. Study on Geomagnetic Variation of Telluric Origin Part III. On Geomagnetic Anomaly Observed at Some Hot Spring Areas. Bulletins - Disaster Prevention Research Institute, Kyoto University 1962, 51: 46-60

ISSUE DATE:

1962-02-20

URL:

http://hdl.handle.net/2433/123711

Study on Geomagnetic Variation of Telluric Origin

Part III. On Geomagnetic Anomaly Observed at Some Hot Spring Areas

By

Junichiro MIYAKOSHI

Institute of Earth Science, Tottori University
(Communicated by Prof. E. Nishimura)

Abstract

A magnetic survey for vertical intensity was made at some areas of hot spring in Tottori Prefecture, to examine the relation, if existing, between the magnetic anomaly and hot springs. It was found that a correlation probably existed between the site of a hot spring and negative zone of geomagnetic vertical intensity.

1. Introduction

The problem of distribution of geomagnetic anomaly all over the world or at some special regions is an old item since the early age of Gauss's brilliant works on geomagnetism. On the other hand, the geomagnetic method of prospecting on iron-ore and other magnetic substances has been increasingly applied for practical purpose of finding the subterranean resources. Recently the aerial survey with an air-borne magnetometer has made a survey on the ocean, in an inaccessible area of thick forest and high mountain, possible and detailed maps of geomagnetic element have been accomplished everywhere on the earth.

Recently F. E. Studt (1959), by a magnetic survey at Wairakei hydrothermal field in New Zealand, found a low magnetic intensity in the area of hot spring compared with that of its surrounding area. In the present paper, following Studt's investigation, a result of magnetic survey made at some areas of hot spring in Tottori Prefecture, is described.

2. Instrument

The instrument used in the present investigation is a magnetometer of vertical intensity designed by Prof. Y. Kato, Tohoku University and constructed by Sokkisha Manufactory, and called Z-GIT magnetometer. The principal functions of this instrument is as follow : first, the electric oscillating current of 1 kc/s is fed to the primary coil wound round the cylinder of permalloy which is uprightly set and the induced current of 2 kc/s in the secondary coil by effect of vertical component of geomagnetism, is selectively amplified. Second, this 2 kc/s current is eliminated by current of the third coil which cancels the vertical intensity of geomagnetism. Namely the value

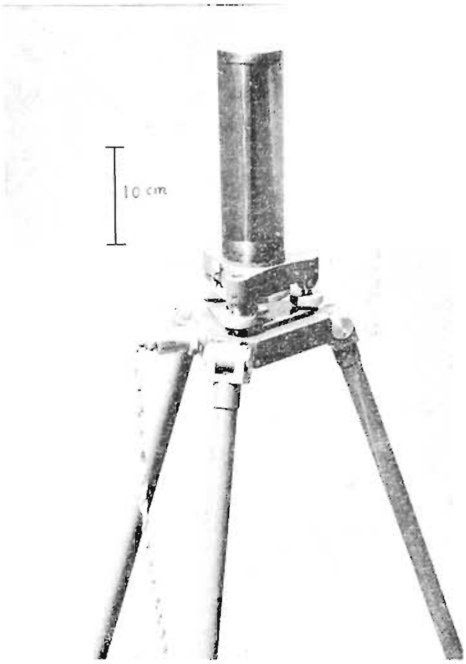

Fig. 1a. Main part of Z-GIT magnetometer.

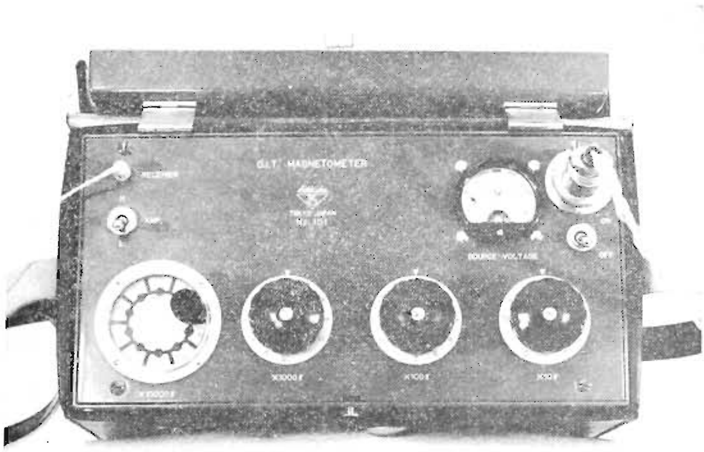

Fig. 1b. Electric box of Z-GIT magnetometr.

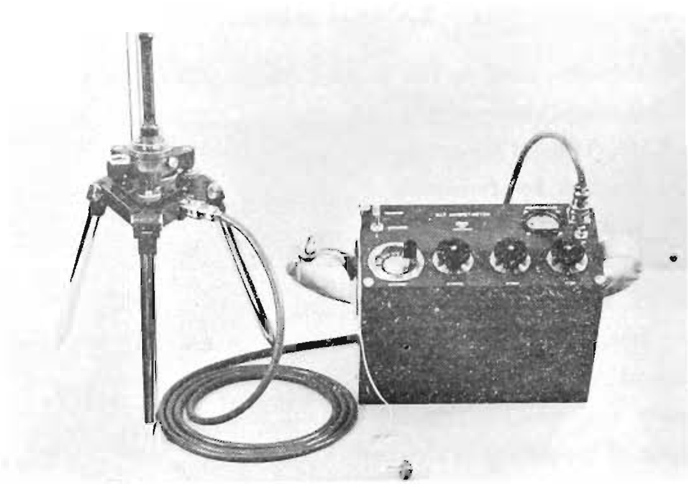

Fig. 2. Whole aspect of Z-GIT magnetometer.

of z-component of geomagnetism is measured by the zero-method and indicated as resistance of the third coil which is variably controlled. The accuracy of this instrument is regarded 10γ. Dimension and appearance of the principal part with a primary, secondary and third coil, and equipment of the electric system, are show in Fig. 1a, Fig. 1b and Fig. 2.

As the instrument was recently designed and manufactured in trial, its reliability for field survey must in detail be examined. For this purpose several trial surveys were made at some different places and a surprisingly large fluction of z-value at a point was found everywhere in the survey area, the maximum range of fluctuation reaching 100γ. After several trial surveys it was found that these large fluctuations were caused mainly by collimation error of the permalloy cylinder. This collimation error was in minimum reduced by the trial and error method in practical survey. But there remained another problem of effect of air temperature and sunshine upon the measured value of z-component. It was considered difficult to fully eliminate this temperature effect. Consequently in the present stage, the survey was made mainly at night from 22h to 5h. Under these cautious treatment and survey the obtained result in the present survey showed 20γ as the probable accuracy of this instrument. In the following one would find magnetic surveys with this Z-GIT carried out at several places of hot spring in Tottori Prefecture.

3. Magnetic Survey

As a first step, magnetic effects by building of reinforced concrete, wooden building, and railway upon the z-value in magnetic survey when these constitutions were close to the measuring point, were investigated. As seen in Fig. 3 and Fig. 4, the effect by a reinforced concrete building was negligiblly small (50γ) at the point beyond the horizontal distance of four times of the height of building. Concerning the effect by wooden building the effect vanished at 4 m from the building as seen Fig. 5. It

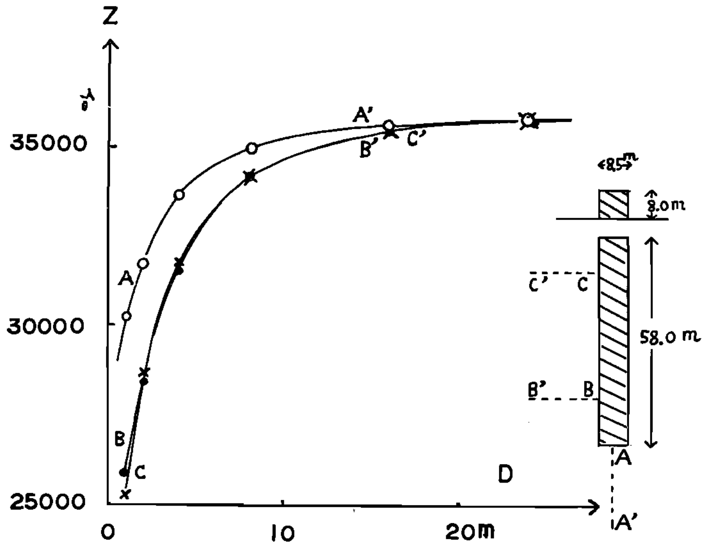

Fig. 3. Effect on magnetic field by a reinforced concrete building.

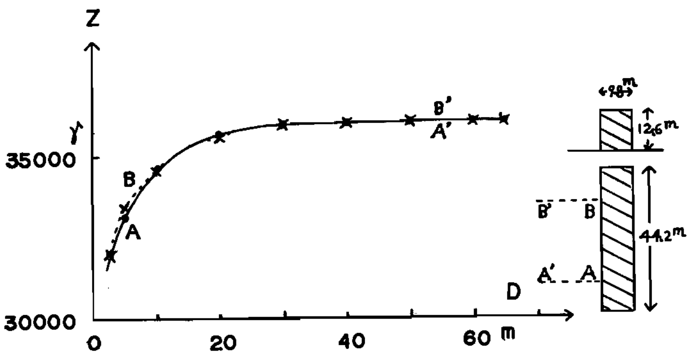

Fig. 4. Effect on magnetic field by a reinforced concrete building.

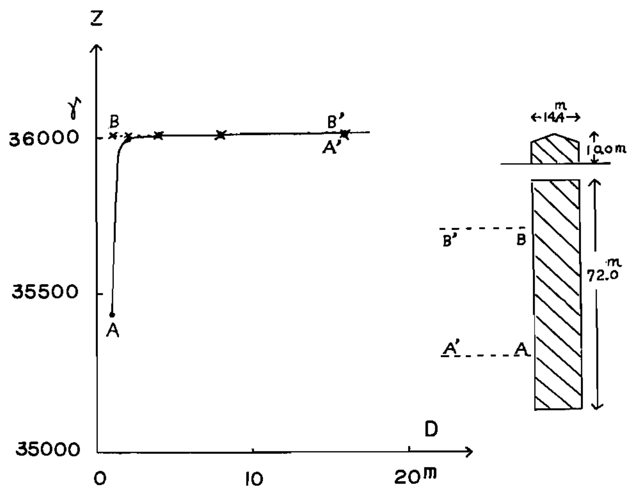

Fig. 5. Effect on magnetic field by a wooden building.

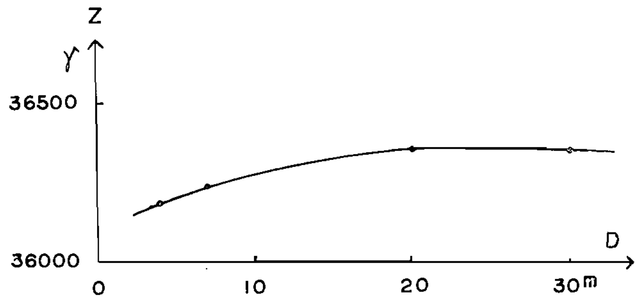

Fig. 6. Effect on magnetic field by a railway road.

was also ascertained that the survey must be made more than 20 m from the railway, as seen in Fig 6. From these observations the distance of the survey point from the reinforced concrete building, the wooden building, and the railway was practically kept more than 100 m, 30 m and 50 m respectively. And the value of survey in a magnetically stormy day was corrected, if in need, by the data of continuous self-recording observation with the z-variometer at the Momodani Observatory in Tottori.

The areas of hot springs surveyed were Yoshioka, Hamamura, Shikano, Matsuzaki, Misasa, and Kaike, all in Tottori Prefecture, and besides them the area of sand dunes near Tottori was surveyed. Numerical data and maps were shown in Figs. 7～13 and Tables 1～7.

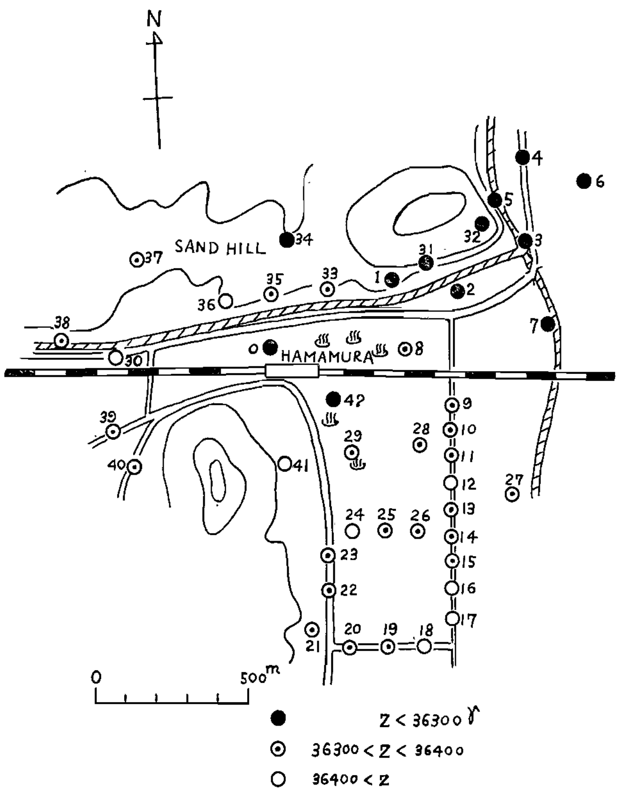

Fig. 8. Anomaly of geomagnetic vertical intensity observed at Hamamura.

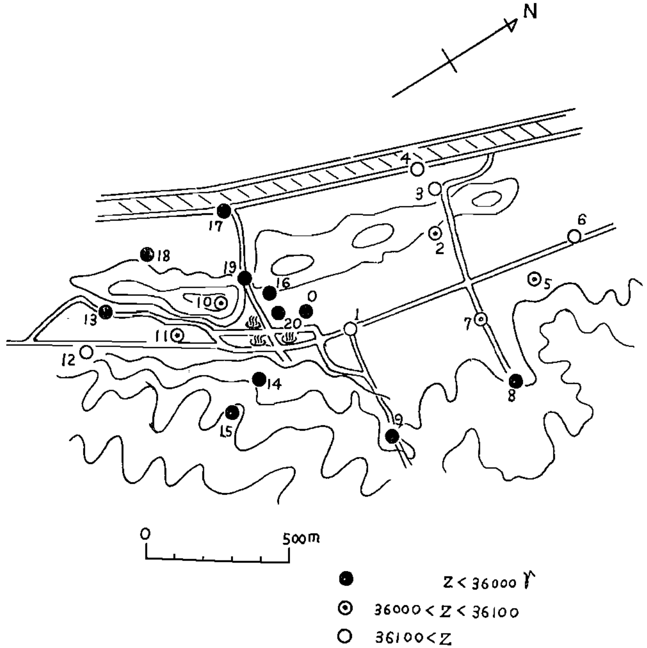

Fig. 7. Anomaly of geomagnetic vertical intensity observed at Yoshioka.

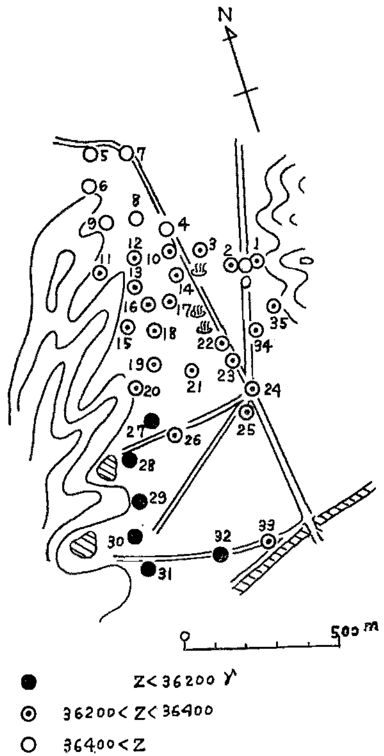

Fig. 9. Anomaly of geomagnetic vertical intensity observed at Shikano.

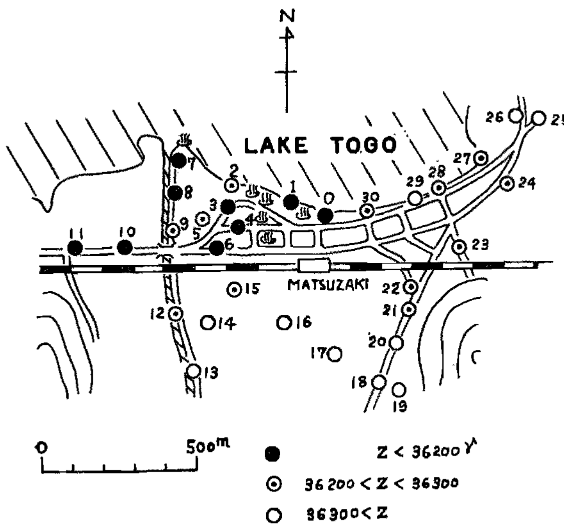

Fig. 10. Anomaly of geomagnetic vertical intensity observed at Matsuzaki.

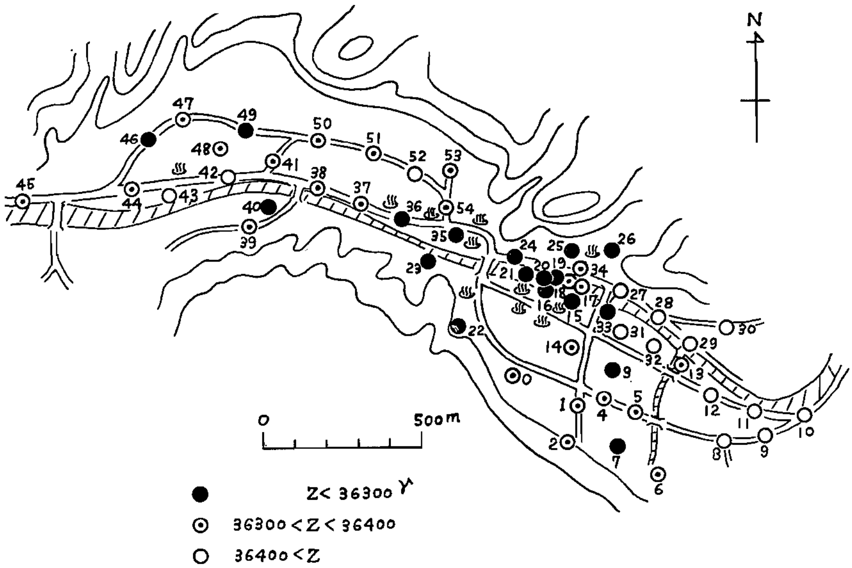

Fig. 11. Anomaly of geomagnetic vertical intensity observed at Misasa.

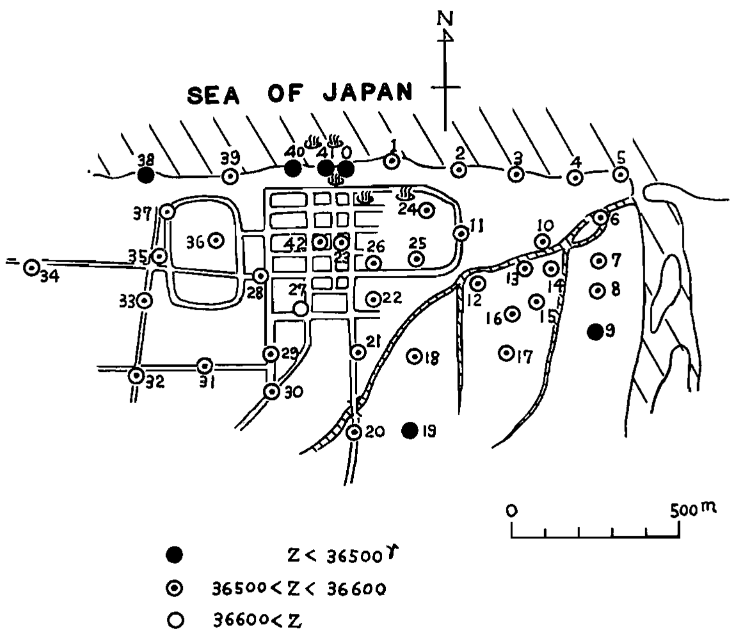

Fig. 12. Anomaly of geomagnetic vertical intensity observed at Kaike.

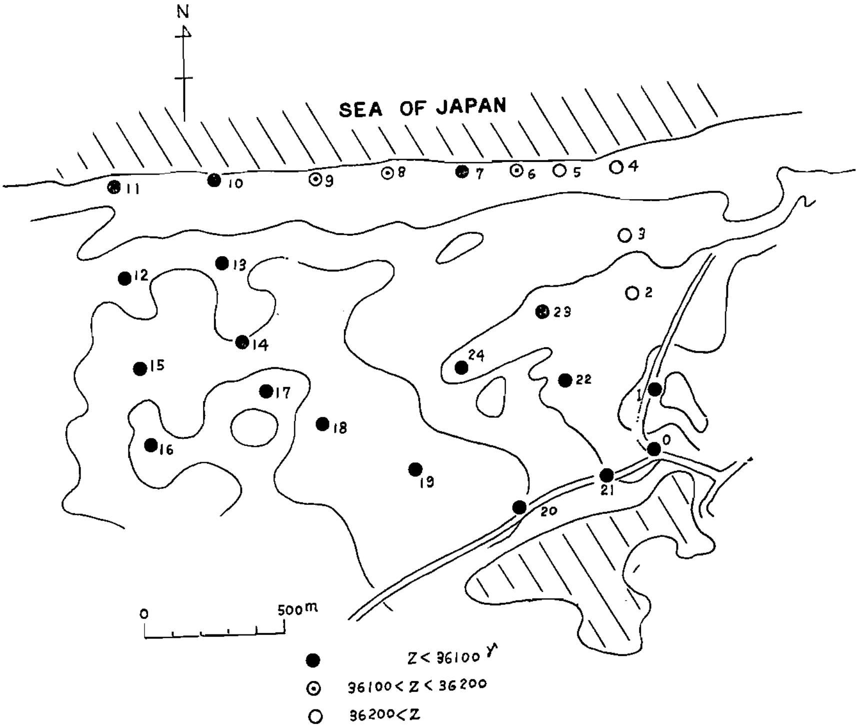

Fig. 13. Anomaly of geomagnetic vertical intensity observed at Tottori Sand Dune.

Table 1. YOSHIOKA

Survey number in Fig. 7	z(γ)	Time h.m.	Date	Survey number in Fig. 7	z(γ)	Time h.m.	Date
0	35905 920	12,40 14,38	May 23, 1961	11	36070	15,12	May 23
1	36295 315	12,48 14,30		12	36140	15,19	
2	36060	12,58		13	35850	15,26	
3	36185	13,06		14	35935	15,40	
4	36120	13,13		15	35995	15,52	
5	36020	13,28		16	35835 820	16,03 16,32	
6	36395	13,35		17	35980	16,13	
7	36085	13,45		18	35975	16,22	
8	35850	13,53		19	35920	16,28	
9	35985	14,91		20	35955	16,35	
10	36050	14,55					

Table 2. HAMAMURA

Survey number in Fig. 8	z(γ)	Time h.m.	Date	Survey number in Fig. 8	z(γ)	Time h.m.	Date
0	36155 165	23,15 3,00	July 7, 1961 July 8	21	36395	1,53	July 8
1	36260 225	23,28 11,15	July 7 Aug. 7	22	36350	1,57	
2	36045	23,40	July 7	23	36355	2,02	
3	36175	23,47		24	36435	2,07	
4	36210	23,53		25	36355	2,10	
5	36250	23,59		26	36310	2,13	
6	36235	0,06	July 8	27	36370 345	2,25 12,55	 Aug. 7
7	36285	0,13		28	36305	2,32	
8	36310	0,27		29	36355	2,36	
9	36350	0,42		30	36340	2,40	
10	36340	0,44		31	36235 (265)	11,19	Aug. 7
11	36355	0,46		32	36245 (275)	11,24	
12	36505	0,48		33	36305 (335)	11,38	
13	36335	1,04		34	36250 (280)	11,45	
14	36330	1,10		35	36275 (305)	11,51	
15	36320	1,15		36	36380 (410)	12,00	
16	36415	1,25		37	36350 (380)	12,10	
17	36485	1,30		38	36310 (340)	12,17	
18	36490	1,40		39	36350 (380)	12,26	
19	36390	1,45		40	36290 (320)	12,32	
20	36340	1,47		41	36370 (400)	12,42	
				42	36215 (245)	12,48	

( ); Corrected Value

Table 3. SHIKANO

Survey number in Fig. 9	z(γ)	Time h.m.	Date	Survey number in Fig. 9	z(γ)	Time h.m.	Date
0	36450 36465	22,25 2,33	July 8, 1961 July 9	3	36375	22,45	July 8
1	36295	22,30	July 8	4	36465 455	22,48 23,31	
2	36355	22,37		5	36475	22,56	

6	36455	23,03	July 8	21	36260	0,50	July 9, 1961
7	36500	23,08		22	36335	0,55	
8	36475	23,18		23	36270	1,00	
9	36445	23,25		24	36275 275	1,07 2,14	
10	36390	23,36		25	36230	1,12	
11	36390	23,42		26	36220	1,18	
12	36395	23,46		27	36195	1,26	
13	36360	23,51		28	36195	1,32	
14	36310	0,08	July 9	29	36055	1,38	
15	36250	0,20		30	36145	1,44	
16	36215	0,25		31	36055	1,47	
17	36395	0,32		32	36185	1,54	
18	36305	0,36		33	36270	2,00	
19	36290	0,39		34	36285	2,19	
20	36215	0,45		35	36225	2,25	

Table 4. MATSUZAKI

Survey number in Fig. 10	$z(\gamma)$	Time h.m.	Date	Survey number in Fig. 10	$z(\gamma)$	Time h.m.	Date
0	36155 36185	22,08 2,00	July 19, 1961 July 20	12	36240 36245	23,56 0,16	July 19 July 20
1	36150	22,15	July 19	13	36300	0,05	
2	36245	22,21		14	36320	0,10	
3	36065	22,28		15	36280	0,22	
4	36175	23,06		16	36345	0,28	
5	36200	23,10		17	36320	0,34	
6	36175	23,18		18	36345	0,44	
7	36180	23,28		19	36320	0,48	
8	36185	23,32		20	36305	0,54	
9	36260	23,37		21	36290	1,00	
10	36095	23,42		22	36285	1,03	
11	36020	23,47		23	36100	1,11	

24	36155	1,19	July 20	28	36235	1,41	July 20
25	36425	1,26		29	36325	1,45	
26	36355	1,32		30	36270	1,52	
27	36155	1,38					

Table 5. MISASA

Survey number in Fig. 11	z(γ)	Time h.m.	Date	Survey number in Fig. 11	z(γ)	Time h.m.	Date
0	36210	22,12	July 26, 1061	21	36070	0,16	July 27
	36265	4,28	July 27	22	36200	0,28	
1	36225	22,22	July 26	23	36130	1,09	
	36250	4,32	July 27	24	36150	1,20	
2	36250	22,27	July 26		36145	2,24	
3	36200	22,35		25	36150	1,25	
4	36240	22,42			36170	2,20	
5	36285	22,47		26	36170	1,32	
6	36255	22,54		27	36420	1,35	
7	36155	23,00		28	36544	1,40	
8	36335	23,06		29	36385	1,45	
9	36470	23,10		30	36465	1,50	
10	36590	23,15		31	36350	1,58	
11	36475	23,19		32	36555	2,05	
12	36330	23,25		33	36180	2,10	
13	36340	23,33		34	36370	2,15	
14	36240	23,45		35	36000	2,32	
15	36110	23,51		36	36175	2,36	
16	36055	23,55		37	36205	2,43	
17	36300	0,00	July 27	38	36305	2,48	
18	36255	0,04		39	36255	2,53	
19	36155	0,09		40	36135	2,58	
20	36155	0,13		41	36295	3,03	

42	36305	3,06	July 27	49	36170	3,48	July 27
43	36305	3,16		50	36250	3,54	
44	36215	3,28		51	36260	4,00	
45	36285	3,28		52	36300	4,05	
46	36105	3,36		53	36260	4,09	
47	36220	3,40		54	36275	4,13	
48	36250	3,45					

Table 6. KAIKE

Survey number in Fig. 12	z(γ)	Time h.m.	Date	Survey number in Fig. 12	z(γ)	Time h.m.	Date
0	36485	21,20	July 31, 1961	18	36525	0,05	Aug. 1
	510	3,33	Aug. 1	19	36455	0,12	
1	36525	22,04	July 31	20	36535	0,22	
2	26530	22,09		21	36515	0,30	
3	36530	22,17		22	36540	0,36	
4	36545	22,26		23	36535	0,44	
5	36535	22,30		24	36540	1,10	
6	36560	22,37		25	36535	1,17	
	550	23,02		26	36570	1,23	
7	36525	22,45		27	36625	1,32	
8	36510	22,49		28	36530	1,44	
9	36480	22,53		29	36565	1,51	
10	36560	23,12		30	36540	1,56	
11	36535	23,20		31	36550	2,04	
12	36555	23,28		32	36550	2,10	
13	36525	23,32		33	36545	2,17	
14	36530	23,38		34	36555	2,24	
15	36540	23,45		35	36525	2,32	
16	36535	23,49		36	36550	2,38	
17	36520	23,57		37	36520	2,45	

38	36490	2,55	Aug. 1	41	36490	3,21	Aug. 1
39	36525	3,12		42	36500	3,42	
40	36455	3,17					

Table 7. TOTTORI SAND DUNE

Survey number in Fig. 13	z(γ)	Time h.m.	Date	Survey number in Fig. 13	z(γ)	Time h.m.	Date
0	35965	14,30	July 25, 1961	12	36050	17,02	July 25, 1961
	35995	18,21		13	36055	17,08	
1	36080	14,42		14	36050	17,15	
2	36280	14,56		15	36050	17,23	
3	36445	15,04		16	36010	17,28	
4	36485	15,14		17	36030	17,35	
5	36345	15,23		18	36015	17,45	
6	36115	15,42		19	36015	17,53	
7	36085	16,13		20	36000	18,02	
8	36115	16,25		21	35945	18,12	
9	36110	16,40		22	35980	18,32	
10	36035	16,47		23	36035	18,42	
11	36060	16,55		24	36025	18,55	

As seen in the Figures and Tables, the z-value at the point of hot spring well showed generally a small value or, in another word, they were generally in a negative zone of z-value. It, however, would be dangerous to draw any definite conclusion only from the above mentioned fact, because the z-value at any point was greatly influenced by the surrounding geological formation and topographical condition. But it might certainly be said that the existence of underground vein or stream of hot spring give some influence upon the value of geomagnetic element, and in the present case, the fact that almost all points of hot spring-well were observed in the area of negative anomaly of geomagnetic vertical intensity is very interesting and suggestive for study of the structure and formation of hot springs.

4. Summary

A tentative survey with a portable magnetometer of vertical intensity was operated at several areas of hot spring in Tottori Prefecture. Before commencement of the survey, the trial observation for testing the reliability of this magnetometer was in detail made, and the closing error in one area on same nights was 20γ in mean. It was found that the points of hot spring-well were almost in the negative anomaly zone of vertical intensity ($-100\gamma \sim -200\gamma$) suggesting a future development of this method in study of underground veins or streams of hot spring.

Acknowledgments

The writer wishes to express his hearty thanks to Prof. E. Nishimura for his kind guidance and encouragement through the whole study, and to Prof. Y. Tamura and Prof. M. Ota for their instructive advices throughout the present study. Many thanks are then due to Dr. Y. Kishimoto for his kind help in analysing the data. The writer is also greatly indebted to the director and members of the Ezaki Lighthouse Bureau of Hydrographical Office, Shimonoseki City and Shimonoseki Branch of Japan Highway Corporation for their kind permission for the use of part of their institution as an observation room during a period. The expenses for observation were defrayed partly by a Grant in Aid for Scientific Research from the Ministry of Education, and partly by the Research Funds of the Disaster Prevention Research Institute of Kyoto University.

References

1) Modriniak, N. and Studt, F. E. 1959 : Geological Structure and Volcanism of the Taupo-Tarawera District, New Zealand Jour. Geology and Geophysics, 2, 4, 654-684.

2) Studt, F. E., 1959 Magnetic Survey of the Wairakei Hydrothermal Field, New Zealand Jour. Geology and Geophysics, 2, 4, 746-754.